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Original Article

Efficacy of Shock Wave Lithotripsy in Lower Ureteric Calculus

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Abstract

Introduction: Extracorporeal shock wave lithotripsy (ESWL) and ureteroscopy (URS) are effective treatments in the management of ureteric calculus. ESWL is noninvasive, associated with less morbidity than URS. Moreover, URS requires specialized training, requires more anesthesia, and more often requires ureteral stent placement. We have analyzed the efficacy of ESWL in the management of lower ureteric calculus.

Materials and Methods: Study conducted in the patients attended in the urology clinic for the management of lower ureteric calculus. Forty-eight patients were included in the study. Informed consent obtained from all the patients after explaining all available modalities of treatments and they are divided into two groups based on stone size, Group 1: ≤10 mm and Group 2: >10 mm. These patients were again divided based on computed tomography-hounsfield unit (CT-HU) into Groups A and B, Group A: ≤1000 Group B: >1000 HU. All the patients underwent ESWL in donier compact delta II (electromagnetic generator) machine as outpatient procedure. Study data analyzed using SPSS (V: 17) software.

Results: Results of 48 patients analyzed. Stone-free rate in ≤10 mm group was 22/25 patients (88%) and in >10 mm group was 13/23 patients (56.5%) $P < 0.01$. When CT-HU increases success rate decreases, when HU was ≤1000 (Group 1A and Group 2A) 34 patients (85%) successfully cleared their stones, failure occurred only in 6 patients (15%). When HU > 1000 (Group 1B and Group 2B) only one patient cleared the stone (12.5%), failed in 7 patients (87.5%), this difference was statistically significant ($P < 0.001$).

Conclusion: *In situ* ESWL for lower ureteric calculus is an effective, non-invasive, and a viable treatment option with no major complications. Patients with lower ureteric calculus size ≤10 mm and CT-HU ≤ 1000 had high expulsion rate with ESWL. Other modalities of treatment may be needed in patients with stone size >10 mm and CT-HU > 1000.

Key words: Computed tomography hounsfield unit, Dornier compact delta II, Extracorporeal shock wave lithotripsy, Lower ureteric calculus

INTRODUCTION

The indications for intervention in the management of patients with ureteric calculi have clearly been affected by the increased efficiency and lower morbidity of minimally invasive treatment modalities. Lingeman *et al.* reported that when a patient requires hospitalization, it is less costly to remove the patient's stone with either SWL or ureteroscopy (URS) than to attempt to control the patient's symptoms with pharmacotherapy only. However, many patients will pass the stone spontaneously.[1,2] Segura[3] and associates reported on the management of patients with ureteric calculi that for patients with stones of 5 mm or less, conservative management should be considered, whereas the chance of spontaneous passage for larger stones diminishes considerably, and intervention is recommended. The density of stone measured by non-contrast computed tomogram hounsfield unit (HU) varies with composition and determines the fragility of a calculus which ultimately governs the clinical outcome in extracorporeal shock wave lithotripsy (ESWL). Perhaps the greatest dilemma facing the urologist today is "to blast or not to blast" (i.e., to choose between the two most frequently used modalities in ureteric stone treatment-ESWL and URS). We studied

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the efficacy of extracorporeal SWL in the management of lower ureteric calculus.

MATERIALS AND METHODS

Patients presented or referred to urology clinics for the management of lower ureteric calculus were included in the study. The institutional review board at our hospital approved the study. Informed consent obtained from all the patients after explaining all available modalities of treatments - medical expulsion therapy, URS and intracorporeal lithotripsy and extracorporeal lithotripsy, their complications in the management of lower ureteric calculus. History, physical examination, complete hemogram, urine routine and culture sensitivity, renal function test, X-ray kidney, ureter, and bladder (KUB), ultra sonogram KUB, contrast-enhanced computed tomography (CT) KUB. Lower ureteric calculus - stones below sacroiliac joint to vesico ureteric junction. Stone size measurements taken in the study were maximal transverse measurement in CT, and CT-HU of stones were measured simultaneously.[4]

Patients included in the study are divided into two groups based on stone size. Group 1: ≤10 mm and Group 2: >10 mm. Patients again divided based on CT-HU into Groups A and B, Group A: ≤1000 Group B:> 1000 HU. Hence, study group contains Group 1A: ≤10 mm and HU: ≤1000, Group 1B: ≤10 mm and HU > 1000, Group 2A: >10 mm and HU: ≤1000, and Group 2B: >10 mm and HU > 1000.

Patients not willing for ESWL, bilateral ureteric calculi, ureteric obstruction distal to calculus, coagulation disorder/patients on anticoagulation drugs, pregnancy, sepsis, and end-stage renal disease were excluded from the study. ESWL was done with dornier compact delta II (electromagnetic generator) (Figure 1), patients on prone position. Injection pentazocine 30 mgs and Injection promethazine HCl 25 mgs intramuscularly administered 30 min before the procedure. Stone focusing was done fluoroscopically, 2500 shocks given for all patients - 60 shocks/min, in the intensity 4-5. Patients were followed in 15 days, 30 days, 60 days, and in 90 days or whenever patients had unusual urinary complaints after the procedure. Failure of ESWL - if any significant residual stone after 3 months.

RESULTS

The study comprised 50 patients who had satisfied the inclusion and exclusion criteria. Two patients lost follow-up after ESWL procedure; hence, results of 48 patients analyzed. Age of the patients ranged from 17 to 70 years;

Figure 1: Dornier compact delta II (electromagnetic generator)

most patients were in 21-50 years. There were 35 male and 13 female patients in our study. The majority of patients presented with colicky pain and nausea/vomiting, other symptoms were dysuria and loin pain. Duration of symptoms ranged from 4 days to 1 month. In our study, size of the lower ureteric calculus range from 6 mm to 16 mm. Cases are divided into two groups based on stone size. Group 1: ≤10 mm and Group 2: >10 mm. In Group 1 (≤ 10 mm), 24 patients were with ≤1000 HU - Group 1A and one patient with >1000 HU Group 1B. In Group 2 (>10 mm), 16 patients were ≤1000 HU - Group 2A and 7 patients were with >1000 HU - Group 2B. In our study, left-sided stones predominated (27 points) over right-sided stones (21 points). In this study, one patient in Group 1 (≤10 mm) required second sitting of ESWL, 5 patients in Group 2 (>10 mm) required second sitting. Number of primary treatment increased when CT-HU was >1000 (Group 1B and Group 2B) when compared with CT-HU < 1000 (Group 1A and Group 2A) (Table 1), this difference was statistically significant ($P < 0.01$). Stone-free rate in ≤10 mm group was 22/25 patients (88%), and in >10 mm group was 13/23 patients (56.5%) (Table 2). This difference was statistically significant ($P < 0.01$). In Group 1 (≤10 mm), stone-free rate based on CT-HU showed when CT-HU was ≤1000 success rate significantly higher than >1000 HU ($P < 0.001$). Group 2 (>10 mm) stone-free rate based on CT-HU showed when CT-HU was ≤1000 success rate was 75%, significantly higher than >1000 HU ($P < 0.01$). When CT-HU increases success rate decreases, when HU was ≤1000 (Group 1A and Group 2A) 34 patients (85%) successfully cleared their stones, failure occurred only in 6 patients (15%). When HU > 1000 (Group 1B and Group 2B) only one patient cleared the stone (12.5%), failed in 7 patients (87.5%), this difference was statistically significant ($P < 0.001$) (Table 3). During follow-up of post ESWL, few patients presented with minor complications. Dysuria was the major complication

Table 1: Number of primary treatment based on CT-HU

Number of primary	HU		Total
	≤1000	>1000	
One	37	5	42
% within HU	92.5	62.5	87.5
Two	3	3	6
% within HU	7.5	37.5	12.5
Total	40	8	48
% within HU	100.0	100.0	100.0

HU: Hounsfield unit, CT: Computed tomography

Table 2: Stone-free rate in relation to stone size

Eswl	Size		Total
	Group 1	Group 2	
	≤10 mm	>10 mm	
Success	22	13	35
% within size (cms)	88.0	56.5	72.9
Failure	3	10	13
% within size (cms)	12.0	43.5	27.1
Total	25	23	48
% within size (cms)	100.0	100.0	100.0

ESWL: Extracorporeal shock wave lithotripsy

Table 3: Stone-free rate based on CT-HU

Stone-free rate	HU		Total
	≤1000	>1000	
Success	34	1	35
% within HU	85.0	12.5	72.9
Failure	6	7	13
% within HU	15.0	87.5	27.1
Count	40	8	48
% within HU	100.0	100.0	100.0

HU: Hounsfield unit, CT: Computed tomography

in most number of patients - 12 patients, hematuria in 5 patients, lower abdominal pain in 4 patients, and urinary tract infection in one patient. All complications were treated conservatively with hydration, antibiotics, and analgesics.

DISCUSSION

ESWL has revolutionized the treatment strategy of urolithiasis worldwide and continue to be a major therapeutic modality for treating the majority of upper urinary tract stones. Its non-invasive nature along with high efficacy has resulted in outstanding patient and surgeon acceptance.

The success rate of ESWL is determined by factors such as stone size, composition location, the presence of obstructive changes, and anatomical anomalies. Stone composition is one hidden factor which decides the fragility of calculus and its susceptibility to ESWL. The number of shocks required for fragmentation is related not only to the size of the stone but also to its hardness (or) brittleness which largely depends on its chemical composition.

Recommended treatment options, ESWL and URS, in ureteric stone have valid advantages and disadvantages. Supporters of ESWL claim that it is effective and non-invasive, is associated with less morbidity, requires fewer anesthesias than URS, and seldom requires ureteric stents. Critics argue that the success rates are not as high as those of URS, equipment availability may be limited, visualization of the stone is often difficult, attainment of a stone-free state requires a longer time and follow-up, re-treatment rates are higher, and costs are higher. Supporters of URS claim that it is highly successful and minimally invasive, is associated with minimal morbidity, can be used with larger and multiple stones, and has high immediate stone-free rates. Critics argue that it requires specialized training, requires more anesthesia, and more often requires ureteric stent placement.[18,19]

The primary goal in treating patients with ureteric calculi is a stone-free state, and the American Urological Association/European Association of Urology guidelines panel's meta-analytic study reported that with ESWL in distal ureteric stone <10 mm, in 17 groups containing 1684 patients stone-free rate was 86% (80-91%).[22] In our study, it was 88%. In >10 mm groups containing 966 patients stone-free rate was 74% (57-87%), in our study it was only 56.5%. All ESWL failure cases in our study underwent URS and intracorporeal pneumatic lithotripsy. All patients were stented following the procedure. DJ stents removed after 3 weeks. During URS and intracorporeal lithotripsy (ICL), no significant abnormality in either ureteric orifice or distal ureteric narrowing below the stone was noted.

There have been two randomized prospective studies comparing URS and ESWL for treatment of patients with distal ureteric stones subsequent to the guidelines document. Peschel *et al.* randomized 80 patients and found that those undergoing URS achieved stone-free status more rapidly, regardless of initial stone size, than did those treated by SWL. All of the patients undergoing URS were rendered stone free, whereas 10% of the SWL cohort required subsequent URS to achieve a stone-free status.[23] Pearle *et al.* randomized 64 patients and reported that 100% of individuals who completed radiographic follow-up subsequent to either SWL or URS became stone free.[24]

One possible reason for the difference in this outcome compared with the Pearle *et al.* study is that an unmodified dornier HM3 lithotripter, which is known to fragment stones more efficiently, was used in Pearle's study rather than the dornier MFL5000 used in Peschel's study. In

our study, overall success rate was 72.9%; 27.1% of patients required secondary treatment. The lithotripter used was dornier compact delta II (electromagnetic generator). Joseph *et al.*[25] assessed the susceptibility of stone fragmentation by ESWL according to HU in renal stone, they found that the success rate for stone with attenuation value ≤1000 HU was significantly higher than that for stone with value >1000 HU.[25] In their study, they found a significant correlation between number of shocks required for stone fragmentation and the attenuation value of the stone.

Not much of data available in the literature on correlation between HU and stone-free rate in lower ureteric calculus. In our study, significant failure and retreatment rates in >1000 HU stones, both in Group 1 (≤10 mm) and Group 2 (>10 mm), but the number of patients in our study with HU > 1000 were small (8/48). Yip *et al.* studied efficacy of *in situ* ESWL in ureteric calculi management using dornier MFL 5000 lithotripter, their overall success rate was 81%,[26] in our study it was 72.9%. Ghafoor *et al.* studied the efficacy of ESWL in the treatment of lower ureteric stones using second generation Siemens Lithostar II. Clearance rate for small stones (<10 mm) in the lower third of the ureter was 73.8%, and for stones larger than 10 mm in the distal third of ureter, the clearance rate was low 42.8%, with a high retreatment rate. Hence, Ghafoor *et al.* concluded that for distal ureteric stones <10 mm in diameter, the clearance rate is more than 70% and ESWL can be considered as a primary treatment, while for stones larger than 10 mm in diameter, endoscopic removal should be the preferred treatment.[28]

In our study, the results were far better than Ghafoor *et al.* study, the clearance rate for small stones (<10 mm) was 88% compared with 73.8%. Clearence rate for stones larger than 10 mm was 56.5% still better than Ghafoor *et al.* study 42.8%.

In our study, total of 48 patients underwent *in situ* ESWL of lower ureteric calculus, 25 patients with stone size ≤10 mm, and 23 patients with >10 mm size. Dornier compact delta II was used in this study. All procedures were done as outpatient treatment. Overall stone-free rate was 72.9%, there were 27.1% patients required URS/ICL as secondary procedure.

In patients with stone size of ≤10 mm (Group 1) success rate was 88%, when CT-HU was ≤1000 (Group 1A) the success rate increased to 91.7%. In patients with stone size of >10 mm (Group 2) success rate was 56.5%, when CT-HU was ≤1000 (Group 2A) the success rate increased to 75%. Patients with CT-HU > 1000 retreatment and failure rate statistically increased when compared to ≤1000 HU stone patients in both groups. Overall failure rate in ≤10 mm (Group 1) was 12%, only one patient with CT-HU > 1000 (Group 1B) failed to clear the stone. Overall failure rate of *in situ* ESWL in >10 mm stone size patients were 43.5% (Group 2). When CT-HU was <1000 (Group 2A) it was only 25%, in patients with stone size >10 mm with CT-HU (Group 2B) stone clearance failed in all except one - 85.71%.

CONCLUSION

In situ ESWL for lower ureteric calculus is an effective, non-invasive, and a viable treatment option with no major complications. Patients with lower ureteric calculus size ≤10 mm and CT-HU ≤ 1000 had high expulsion rate with ESWL. Hence, ESWL may be considered as the primary treatment option. Other modalities of treatment may be needed in patients with stone size >10 mm and CT-HU > 1000. Patients with lower ureteric calculus size >10 mm and CT-HU ≤ 1000, ESWL can be tried with reasonable success.

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